# LEFT VENTRICULAR DIASTOLIC DYSFUNCTION IN PATIENTS WITH CONGESTIVE HEART FAILURE

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**This study reviewed 372 male patients with congestive heart failure. Two hundred and eighty-three (77%) had congestive heart failure due to systolic dysfunction as demonstrated by radionuclide angiography. Eighty-seven (23%) with congestive heart failure were identified who had normal ejection fractions. All patients met the Framingham criteria for congestive heart failure. These 87 individuals had unrecognized diastolic heart failure. It is important to distinguish between systolic and diastolic heart failure because the pathophysiology, treatment, and prognosis differ significantly. The most frequent cause of diastolic heart failure in this study was hypertension. Diastolic dysfunction should be considered in patients with acute heart failure and severe uncontrolled hypertension, or in patients with ischemic heart disease who develop acute pulmonary edema. Patients who do not respond or deteriorate when treated for heart failure using conventional therapy may also have diastolic dysfunction. These patients warrant special recognition and tailored management.**

**Key words** • congestive heart failure • systolic heart failure • diastolic heart failure

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Heart failure is a major health problem in the United States and the mortality is high.[1] Approximately 400 000 new cases are diagnosed annually. Five-year survival is about 50%, but many patients with class III or IV symptoms die within 12 months of diagnosis despite optimal therapy. There has been a steady increase in frequency, a trend that will continue with our growing elderly population.[2]

Our appreciation of congestive heart failure has changed dramatically in the past few years. Classic thinking may overlook 30% to 50% of patients who have symptoms of heart failure, even though ejection fractions are normal.[3-7] It is important to distinguish between systolic and diastolic heart failure because the pathophysiology, treatment, and prognosis differ significantly. We report a radionuclide study of 87 male patients with congestive heart failure due to unrecognized diastolic dysfunction.

## METHODS

This retrospective study reviewed 372 male patients with heart failures who had gated radionuclide angiographies to assess left ventricular function, performed in our hospital over 2 1/2 years. Clinical diagnoses were obtained from procedure requisition slips. Normal systolic function was defined as a left ventricular (LV) ejection fraction of 45% or greater. Diastolic function was derived from radionuclide angiographic left ventricular time-activity curves using the peak filling rate (PFR). The peak filling rate represents the maximal rate of change in counts during early to mid-diastole. Time to peak filling rate is expressed as end-diastolic volume/second and is normalized for the number of counts in end-diastole. Data were expressed as mean ± standard deviation.

**TABLE. CONGESTIVE HEART FAILURE WITH NORMAL SYSTOLIC FUNCTION**

| Study | Patient No. | Sex F/M | Mean Age | HTN % | CAD % | Others No. |
|---|---|---|---|---|---|---|
| Dougherty[3] | 17 | 1.1 | 63 | 65 | 53 | 0 |
| Soufer[4] | 36 | -- | 68 | 33 | 27 | 52 |
| Bier[5] | 38 | 1.5 | 73 | 58 | 59 | 9 |
| Echeveirra[6] | 20 | 1.2 | 51 | 65 | 5 | 30 |
| Topol[9] | 21 | 3.2 | 73 | 100 | -- | -- |
| Cregler | 87 | -- | 63 | 56 | 41 | 14 |

HTN = Hypertension and CAD = Coronary artery disease. (Adapted from Sonnenblick et al.[7])

The 372 patients referred for radionuclide angiography were divided into two groups, those with an ejection fraction greater than 45%, and those with less than 45%. Two hundred and eighty-three patients (77%) had congestive heart failures due to systolic dysfunction. The remaining 89 patients (23%) had normal ejection fractions but two hospital charts could not be found and were not reviewed. Thus, the charts and records of 87 patients were reviewed by one of the investigators to validate the diagnosis of heart failure using the Framingham criteria.[8]

A diagnosis of definite congestive heart failure was established if two major, or one major and two minor criteria were present. The major criteria used were paroxysmal nocturnal dyspnea, neck vein distension, rales, cardiomegaly, $S_3$ gallop, and acute pulmonary edema. The minor criteria included pedal edema, dyspnea on exertion, hepatomegaly, pleural effusion, and tachycardia. Probable congestive heart failure was accepted when either one major and one minor, or two or more minor criteria were present, and the physician had listed the diagnosis as CHF.

## RESULTS

Thirty-nine patients had definite congestive heart failure using the Framingham criteria. The mean age of this group was 65 ± 12 years (range: 35-91 years). Twenty-six individuals were receiving digitalis and 36 were on diuretic therapy. Twenty-five patients had hypertension and 20 had coronary artery disease. The LV ejection fraction in this group was 58 ± 8% (range 46%-80%). A normal peak filling rate is >2.50 volume/second (mean 4.04 ± 0.77) as previously reported.[4] The peak filling rate for this group was 2.18 ± 0.59 volume/second and this was significant at a $P<0.01$ level.

The remaining 48 patients had probable congestive heart failure. The mean age of this group was 62 ± 11 years (range 36-77 years). Twenty-four patients had hypertension, 16 had coronary artery disease, and 14 had a diagnosis of alcoholism. Four individuals were receiving digitalis and 23 were on diuretics. The majority of these individuals were being treated with calcium-channel or beta-blockers. The LV ejection fraction in this group was 59 ± 7% (range 49%-70%). The peak filling rate was 2.23 ± 0.62 end-diastolic volume/second and this was also significant at the $P<0.01$ level.

## DISCUSSION

The prevalence of left ventricular diastolic dysfunction in this study was slightly lower than previously reported by Dougherty[3] and Soufer.[4] They reported that one-third or more of their patients, in heart failure, had diastolic dysfunction. Using echocardiography, Topol demonstrated that older hypertensive black women have a high incidence of diastolic heart failure.[9] Heart failure in patients with aortic stenosis is often due to left ventricular diastolic dysfunction.[10] Our study differs because we have no female patients and we excluded patients with aortic stenosis (Table). Congestive heart failure due to diastolic dysfunction may result from myocardial hypertrophy, ischemia, reduced atrial function, or restrictive pattern due to premature aging, all compounded by impaired sodium excretion.[11,12] During myocardial ischemia, diastolic dysfunction often precedes systolic dysfunction.[13] Diastolic dysfunction can occur without abnormal systolic function, particularly in patients with hypertension, hypertrophic cardiomyopathy, coronary artery disease, aortic valvular disease, and in the elderly.[6,11,14-17]

Essential hypertension, accompanied by increased arteriolar and arterial wall thickness and stiffness, is the most frequent cause of diastolic heart failure.[7] Data from Framingham indicate that hypertensive patients have a six-fold increase in the likelihood of developing congestive heart failure, [8] but diastolic abnormalities often precede systolic impairment.[18] The majority of patients with diastolic dysfunction have predominantly left-sided findings, minimally-displaced apical im-

pulses, a fourth heart sound, and rarely a third heart sound.[19] Patients who do not respond or deteriorate when treated for heart failure may have diastolic dysfunction.[7]

Heart failure due to diastolic dysfunction is not easily distinguished by clinical examination, and many patients simply go unrecognized. Noninvasive studies have contributed vastly to our understanding of diastolic function.[20] Doppler echocardiography, radionuclide angiography, and cineangiography can all be used to distinguish between systolic and diastolic dysfunction.[21-24] The invasive measurement of left ventricular pressure decay is probably the "gold standard." The peak filling rate of change in left ventricular pressure during early diastole is measured along with pressure decay during isovolumic relaxation.[25] Peak filling rates obtained using Doppler ultrasound correlate well with angiography. Left ventricular diastolic filling is a complex phenomenon determined by a myriad of factors, including left ventricular relaxation, preload, afterload, systolic performance, age, and heart rate.[26]

The primary goals in managing diastolic heart failure are to recognize and treat the underlying pathophysiologic process.[27] Recognition of diastolic heart failure is most important in planning effective therapy. In some patients it is associated with a mechanical lesion and medical therapy alone is inadequate. Patients in diastolic heart failure due to aortic stenosis and coronary artery disease may require surgery, regardless of response to medical therapy.[28]

Diuretic therapy can produce rapid symptomatic relief from dyspnea and edema. However, the smallest dose of diuretic should be used. One must also be careful of hypotension, and recognize the metabolic disturbances, including potassium depletion and hyperlipidemia associated with its use. Digitalis glycosides are important in treating heart failure, but may be harmful in diastolic dysfunction.[29] The response to digitalis is determined not only by severity of disease, but also by the mechanism producing heart failure.[30] Calcium-channel blockers have been used in the treatment of coronary artery disease and hypertrophic cardiomyopathy. They are negative inotropic agents and probably improve relaxation. Control of hypertension with beta-blockers and calcium-channel blockers will regress hypertrophy and improve diastolic function. Topol et al[9] cautioned against the use of vasodilators in treating hypertensive hypertrophic cardiomyopathy because of hypotensive reactions. Converting enzyme inhibition is an attractive and effective therapeutic modality. It can reduce left ventricular hypertrophy, arterial wall thickness, and stiffness.[7] The converting enzyme inhibitors are the only class of drugs used in heart failure that have been shown to improve symptoms and also to reduce mortality.[31-32] These agents work best in combination with a diuretic and few patients need to discontinue therapy because of adverse side effects. One must carefully evaluate the diagnostic and therapeutic pitfalls when considering this topic of ongoing interest and importance.

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